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EXAMINER	
VAN ROY, TOD THOMAS	
ART UNIT	**PAPER NUMBER**
2828	

DATE MAILED: 02/16/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	**Application No.** 10/661,832	**Applicant(s)** HU ET AL.
	Examiner Tod T. Van Roy	**Art Unit** 2828

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on 23 December 2005.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-18 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-18 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Amendment

The examiner acknowledges the amending of claims 15-16, and the filing of the terminal disclaimer.

Claim Rejections - 35 USC § 112

The rejections to claims 16-17 under 35 USC 112 are withdrawn due to the amending of claim 16, and arguments presented in regards to claim 17.

Response to Arguments

Applicant's arguments filed 12/23/2005 have been fully considered but they are not persuasive.

With respect to claim 1, the applicant has argued that the device and waveguide of Unterrainer would not operate properly due to the change in wavelength to 1 to 10 THz of Xu. The disclosed waveguides of Unterrainer are of a skin depth appropriate for confining the modes of a frequency range of Xu (3000 angstroms, and 2um) and would therefor be functional if used in this regime. Also, Unterrainer discloses the potential benefits of the device and waveguides at THz frequency ranges (col.4 para.3). Finally, one of ordinary skill in the art would be aware of any changes in device operability, namely skin depth, as this is a well known material property and widely used in laser and waveguiding technologies.

The applicant also has stated that Unterrainer has taught away from the use of the double metal waveguides (noting fig.2). This is not believed to be true. Unterrainer has written this article to show the potential of using the double waveguides in quantum

cascade lasers of a wide wavelength range (abs.) to reduce waveguide losses. The characteristics shown in fig.2 are further explained by Unterrainer (col.4 para.4 – col.5 para.1), and reasons for the performance, and how to enhance it, are explained.

With respect to claim 7, the applicant states that Kneissl does not make up for the deficiencies in claim 1, or teach a double-sided metallic waveguide. Claim 7 states that one of the sides of the guide has a layer of gold deposited over a layer of titanium. Unterrainer teaches both materials to be present on the guide, but is not *specific* as to the order on which they are applied. Kneissl was used, and is believed to be relevant, to simply provide motivation for only the ordering of these materials.

Please see the updated rejections to claims 15-16.

Claims 15 and 17 are rejected under 35 U.S.C. 102(b) as being anticipated by Unterrainer et al. (Unterrainer et al., Quantum cascade lasers with double metal-semiconductor waveguide resonators," Appl Phys. Lett. 80. 3060 (2002)).

With respect to claim 15, Unterrainer discloses a method of confining a mode profile of radiation in a quantum cascade laser comprising: disposing an active region of said quantum cascade laser between an upper and a lower metallic layer (col.3 lines 25-27), wherein each metallic layer has a thickness larger than a skin depth of radiation in a frequency range of about 1 THz to about 10 THz (col.2 lines 36-37 bottom layer-2um, col.3 lines 18-19 top layer 300nm).

With respect to claim 17, Unterrainer discloses the use of a wafer bonding technique to form the structure (col.2 lines 34-39).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-6, 8, and 15-17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Unterrainer et al. (Unterrainer et al., Quantum cascade lasers with double metal-semiconductor waveguide resonators," Appl Phys. Lett. 80. 3060 (2002)) in view of Xu et al. (Xu and Hu, "Electrically pumped tunable terahertz emitter based on intersubband transition," American Institute of Physics (1997)).

With respect to claim 1, Uterrainer teaches an active region for generating THz radiation (col.2 lines 13-15), and a waveguide formed of an upper and lower metallic layer disposed on a surface of said active layer (col.3 lines 25-27) so as to confine

selected modes of said lasing radiation within said active region. Uterrainer does not teach the active region to emit at about 1 to about 10 THz. Xu teaches an active region for generating THz radiation that emits from about 1 to about 10 THz (fig.3). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the THz radiation emitter and waveguide of Unterrainer with the active region of Xu in order to take advantage of the fast depopulation possible through LO-phonon scattering occurring in this material at this frequency range (col.2-3 lines 10-4, fig.3).

With respect to claim 2, Unterrainer and Xu teach the cascade laser outlined in the rejection to claim 1, and further teach the waveguide to have a mode confinement factor of about 1 (Unterrainer, col.2 line 8).

With respect to claim 3, Unterrainer and Xu teach the cascade laser outlined in the rejection to claim 1, and further teach the metallic layers to have a thickness in the range of about .1 to several microns (Unterrainer, col.2 lines 36-37 bottom layer-2um, col.3 lines 18-19 top layer 300nm).

With respect to claims 4 and 6, Unterrainer and Xu teach the cascade laser outlined in the rejection to claim 1, and further teach at least one of the metallic layers to comprise a single layer formed of a selected metallic compound (Unterrainer, col.2 lines 35-37).

With respect to claim 5, Unterrainer and Xu teach the cascade laser outlined in the rejection to claim 1, and further teach one of said metallic layers to comprise a multi-layer structure, being formed by at least two different metallic compounds (Unterrainer, col.3 lines 10-19, top layer comprised of a Ti/Au pad surrounded by additional Au).

With respect to claim 8, Unterrainer and Xu teach the cascade laser outlined in the rejection to claim 1, and further teach the active region to comprise a semiconductor heterostructure providing a plurality of lasing modules connected in series (Unterrainer, col.2 lines 21-32).

With respect to claim 15, Unterrainer teaches a method of confining a mode profile of radiation in a quantum cascade laser comprising: disposing an active region of said quantum cascade laser between an upper and a lower metallic layer (col.3 lines 25-27), wherein each metallic layer has a thickness larger than a skin depth of radiation in a frequency range of about 1 THz to about 10 THz (col.2 lines 36-37 bottom layer-2um, col.3 lines 18-19 top layer 300nm). Unterrainer does not teach the active region to emit at about 1 to about 10 THz. Xu teaches an active region for generating THz radiation that emits from about 1 to about 10 THz (fig.3). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the THz radiation emitter and waveguide of Unterrainer with the active region of Xu in order to take advantage of the fast depopulation possible through LO-phonon scattering occurring in this material at this frequency range (col.2-3 lines 10-4, fig.3).

With respect to claim 16, Unterrainer teaches forming the active region by molecular beam epitaxy (col.2 para.4)

With respect to claim 17, Unterrainer teaches the use of a wafer bonding technique to form the structure (col.2 lines 34-39).

Claims 1, 4, 6, 9-13, and 18 are rejected under 35 U.S.C. 103(a) as being unpatentable over Xu in view of Unterrainer.

With respect to claims 1 and 10, Xu teaches an active region for generating lasing radiation in a frequency range of about 1 to 10 THz (fig.3) including the active region being surrounded by two contact layers (col.1 lines 25-30). Xu does not teach a waveguide formed of metal to confine selected modes of lasing radiation within the active region. Unterrainer teaches an active region, sandwiched by two contact layers (col.2 lines 26-27), for generating THz radiation (col.2 lines 13-15), and a waveguide formed of an upper and lower metallic layer disposed on a surface of said active region (col.3 lines 25-27) so as to confine selected modes of said lasing radiation within said active region. It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the cascade laser of Xu with the metallic waveguide of Unterrainer to obtain high optical confinement factors with low waveguide loss (Unterrainer, abs.).

With respect to claims 4 and 6, Xu and Unterrainer teach the cascade laser outlined in the rejection to claim 1, and further teach at least one of the metallic layers to comprise a single layer formed of a selected metallic compound (Unterrainer, col.2 lines 35-37). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the single layer of gold with the waveguide taught above to function as a surface-plasmon carrying layer (Unterrainer, col.2 lines 37-38), and additionally, it has been held to be within the general skill of a worker in the art to select

a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960).

With respect to claim 9, Xu and Unterrainer teach the cascade laser as outlined in the rejection to claim 1, and further teach a plurality of quantum well structures collectively generating at least an upper lasing state, lower lasing state, and a relaxation state (Xu, fig.1a) such that said upper and lower lasing states are separated by an energy corresponding to an optical frequency in a range of about 1 to 10 THz (Xu, fig.3), and wherein electrons populating said lower lasing state exhibit a non-radiative relaxation via resonant emission of LO-phonons into said relaxation state (Xu, col.2-3 lines 10-4).

With respect to claims 11 and 12, Xu and Unterrainer teach the cascade laser as outlined in the rejection to claim 10, and further teach the contact layers to be heavily doped GaAs (Xu, col.1 lines 25-28).

With respect to claim 13, Xu and Unterrainer teach the cascade laser as outlined in the rejection to claim 9, and further teach the semiconductor heterostructure to be formed of Al(0.3)Ga(0.7)As/GaAs, but do not teach the active region to be composed of Al(0.15)Ga(0.85)As/GaAs. These materials are known in the art to be used with lasers. It would have been obvious to one having ordinary skill in the art at the time the invention was made to make the laser of these known materials, since it has been held to be within the general skill of a worker in the art to select a known material on the basis of its suitability for the intended use as a matter of obvious design choice. *In re Leshin*, 227 F.2d 197, 125 USPQ 416 (CCPA 1960).

With respect to claim 14, Xu and Unterrainer teach the cascade laser as outlined in the rejection to claim 9, and further teach the use of vertical transitions between the upper and lower lasing states to have less susceptibility to interface roughness and impurity scattering (Xu, col.6 lines 12-18).

With respect to claim 18, Xu and Unterrainer teach the cascade laser as outlined in the rejection to claim 1, wherein the laser would inherently function as an amplifier to incoming radiation in the 1 to 10 THz range, and additionally an input port and output port would be located at either facet of the device.

Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Unterrainer in view of Xu and further in view of Kneissl et al. (US 2004/0105471).

With respect to claim 7, Unterrainer and Xu teach the cascade laser as outlined in the rejection to claim 5, but do not specify the Au to cover the Ti. Kneissl teaches a laser structure wherein the electrical contact is formed using Ti covered with Au ([0069]). It would have been obvious to one of ordinary skill in the art at the time of the invention to combine the cascade laser of Unterrainer and Xu with the Au/Ti ordering of Kneissl to improve adhesion to the semiconductor surface as well as a good bonding surface for wire bonding (Kneissl, [0069]).

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Tod T. Van Roy whose telephone number is (571)272-8447. The examiner can normally be reached on M-F.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Minsun Harvey can be reached on (571)272-1835. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

TVR

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PRIMARY EXAMINER